Motorola
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Communications and Electronics Division.

Nov. Dec. 1954

New Motorola Research Laboratory

In this issue . . .

MOTOROLA DEDICATES NEW RESEARCH LABORATORY IN RIVERSIDE, CALIFORNIA
(Pages 10 & 11)

Let's Talk About Quartz Crystals

For the past several years, a multitude of research projects on aging have been sponsored by military laboratories and by independent commercial laboratories. The results of the work show that there are many sources of frequency aging in plated crystals, and most experts seem to agree today that the most difficult effect to control is the one related to the metal surface electrode. Crystals may drift because they are dirty, because they have internal strains, or because of the effect of water vapor or other contaminants passing through cycles of evaporation and condensation. All qualified crystal manufacturers now follow precise procedures to control and prevent contamination in the assembly operation. To minimize the effect of internal strains, the crystals are annealed through a high temperature cycle. Special precautions are taken to insure the deposit of uniform, high quality metal film electrodes. The metal container is evacuated, heated and filled with dry gas before sealing. When all of the precautions and special techniques are followed, the result is the production of an excellent crystal with minimum aging characteristics.

Aging Controlled. I believe it is accurate to state that there is no such thing as a perfect plated quartz crystal unit which will not age, because aging is a question of degree. In a practical sense, however, aging is under control so that a crystal may be expected to continue to function for the life of the equipment within the adjustment range of the crystal oscillator or of the range of the receiver I.F. tuning adjustment.

Adjustment Required. Modern practice in design for I.F. selectivity does not permit the adjustment of an I.F. system with a simple circuit peaking procedure. I prefer to optimize the receiver alignment by a simple crystal oscillator adjustment rather than by attempting to retune the entire precision I.F. system. Field adjustment of modern I.F. systems should be avoided, and in general it may be said that procedures for tuning to precision selectivity characteristics require the use of a laboratory sweep oscilloscope alignment system in the hands of an experienced engineer or technician. This explains why, at Motorola, we reached the considered decision that the best possible systems approach is the use of a sealed filter with permanent and guaranteed selectivity characteristics used in conjunction with a variable crystal oscillator circuit which permits simple and rapid adjustment for perfect receiver alignment and noise balance. The validity and soundness of this design is borne out by the fact that over the past four years about 70% of the new mobile radio equipment placed in service uses this sealed filter and tuned circuit oscillator system. Our receiver system is not only scientifically sound, but it is very, very practicable from a commercial and from a maintenance point of view. This is especially true now, since we are supplying crystals which, from the point of view of stability, reliability, activity, and life characteristics, are far superior to any crystals produced in quantity in former years.

Stability Ratings. Have you ever thought about the job we ask a crystal to do for us? If we rate a crystal at .001%, it means that we expect this crystal to maintain a frequency constant within 10 cycles in each million cycles over a temperature range from about −20° to 150° F. Even with such precision, this means a possible frequency error of 1600 cycles in the 160 megacycle band If you add a possible transmitter drift of 1600 cycles in the opposite direction, you have a total possible drift of 3200 cycles. 3200 cycles is too much of a tuning error to provide the best noise performance for a system. Another way to look at it is that, at .001% we are asking the crystal to maintain a precision equivalent to a little more than six-tenths of an inch in one mile. A carefully ground AT-cut or modified AT-cut crystal can be produced to maintain .001% precision over a portion of the temperature range indicated, but the frequency changes fairly rapidly at the lower temperature and upper temperature sections of the range. If your system operates only in a strong signal area, you can tolerate this temperature frequency change, since the strong signal will give you a sufficient signal-to-noise ratio to maintain communication when the receiver is off carrier tune.

Why the Heater. To improve the precision of the crystal, to insure the best possible communication range, and to guarantee the maintenance of the best signal-to-noise ratio, it is necessary to use a heater. A properly designed crystal associated with the heater can maintain the frequency of oscillation over the ambient temperature range indicated above within a precision of .0003%, or three cycles change in a million cycles, which would mean 480 cycles in 160 megacycles.

Heated crystals should be used in all systems where the ultimate in range and performance is required. Unheated crystals are practicable where some compromise can be accepted with range performance, and where, in general, the operation of the system takes place within a strong signal area and noise increase can be tolerated.

Converting to Split Channel. Conversion from standard channel operation to split channel with Motorola equipment will require only the substitution of the narrow band filter in the receiver and the reduction of transmitter deviation. The precision Motorola heated crystal will do a practical and satisfactory job, but the use of an unheated crystal would seem to be the outside of the limits of the art for the stability required over the usual temperature limits unless afc is used.

Dan Noble

The

Motorola Newsgram

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Communications and Electronics Division

Technical Information Center

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BYRNE HONORED BY INSTITUTE OF RADIO ENGINEERS

MANAGER OF MOTOROLA'S NEW RESEARCH LABORATORY ELECTED IRE DIRECTOR

JOHN F. BYRNE

John Byrne, former director of engineering of Motorola's Communications and Electronics Division and now manager of its new West Coast Research Laboratory, has been accorded one of his professions highest honors by his recent election to the board of directors of the Institute of Radio Engineers. The international IRE society represents some 40,000 radio and television engineers and scientists. Byrne will serve for the 1955-57 term.

During the war, he was Associate Director of Harvard's Radio Research Laboratory where he compiled a distinguished record. For his work at Harvard he was awarded the U. S. Navy Certificate of Commendation and a Presidential Certificate of Merit.

He has been a member of the Panel on Electronic Countermeasures of the Defense Department's Research and Development Board and was Panel Chairman from 1949-51. He has been a member of the same Board's Ad Hoc Committee on Air Defense since 1950. He is a fellow of the IRE, and a member of Tau Beta Pi, Sigma Xi and Eta Kappa Nu.

New Literature . . . .

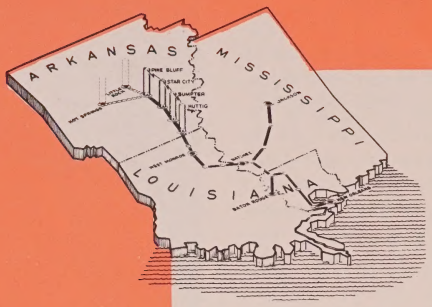
POWER LINE CARRIER SYSTEMS

A new brochure just issued by Motorola explains in detail how modern power line carrier equipment can be used in conjunction with power lines to meet the increasing communications needs of expanding utilities. By employing advanced narrow-band FM techniques to minimize spurious and harmonic transmitter outputs, this equipment achieves extremely close carrier channel spacing for most efficient use of the available carrier spectrum. In addition, each audio channel is capable of simultaneous use for teleprinting, telemetering, load control, supervisory control, etc., as well as voice communications.

The twelve-page technical bulletin delves into the advantages and uses of the three types of power line carrier equipment—manual simplex, automatic simplex, and duplex. Types of telephone termination services provided for each type are tabulated for easy reference. Equipment components, transmitter, receiver, control units, accessories, etc., are described and illustrated.

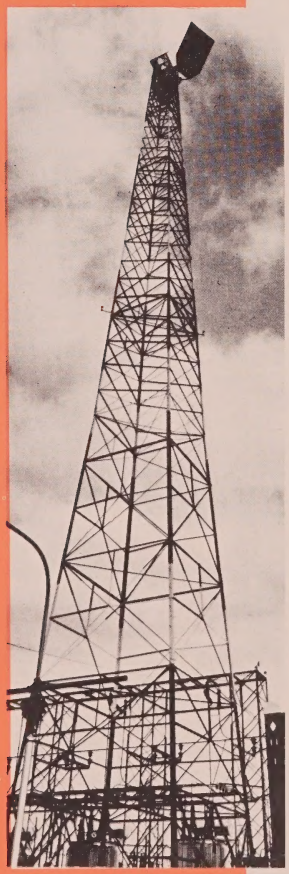
Copies of Bulletin E-111 described above are available upon request from Motorola Communications and Electronics, Inc., National Sales Department.

BUILD LARGEST UTILITIES MICROWAVE SYSTEM



Fully loaded, this new 500-mile system is capable of providing——

- **12,000 circuit-miles of voice communications**
- **48,000 circuit-miles of telemetering**
- **12,000 circuit-miles of supervisory control**



A new message "pipeline" is nearing completion and will soon go on the air serving a southeast power pool consisting of four separate utilities. The system which extends from Pine Bluff, Arkansas on the North to New Orleans on the south with taps to Jackson, Mississippi and Baton Rouge, Louisiana serves an integrated power system including Arkansas Power & Light Co., Louisiana Power & Light Co., Mississippi Power & Light Co., New Orleans Public Service Co. and Gulf States Utilities Co.

The new system is used for voice, load control, telemetering and supervisory control, and is combined with two-way radio, carrier current and PBX telephone systems to provide a complete blanket of communications over the three-state system.

CAPACITY

The system will include 8,100 circuit-miles of communication, utilizing 18 of a possible 24 channels at the present time. Fully loaded, the new microwave system could provide 24 separate voice communications channels. These channels could be divided into 12,000 circuit-miles of voice communication, 48,000 circuit-miles of telemetering and 12,000 circuit-miles of supervisory control. If the system were devoted entirely to narrow band, teletype, telemeter, or relay channels, it would have an ultimate capacity of 216,000 circuit-miles. It is the largest utility installation in the country.

The need for such a system came about because of the rapid growth of power requirements, the trend toward more automatic substations and new developments in load control techniques. Particularly, the new developments in load control facilities demanded channels of higher quality than had been necessary in the past.

To meet these new conditions, it was evident that the existing power line carrier system was completely inadequate in regard to both quality and capacity. Instead, attention was turned to microwave as the system that offered maximum possibilities for expansion and met all the communications requirements for power system operation. A leased line service was also investigated but did not offer sufficient flexi-

bility nor provide room for additional expansion in addition to being more costly.

In the twenty station microwave system, five different types of tower supports are employed. At two of the stations, microwave reflectors that beam the microwave signal in a horizontal direction are located at the top of power plant stacks. Two are on Mississippi River crossing transmission towers. One is located on a tower occupied jointly with the microwave system of a pipeline company. One located in the substation yard at Pine Bluff, Arkansas is of the self-supporting type because with all the substation and transmission facilities surrounding it, there is no place for guy wires. The other towers in the system are standard H-type, guyed towers.

LOAD CONTROL

Frequency of the integrated, four-utility system is regulated by one of the large stations on systems to the northeast, usually the American Gas & Electric system. Tie line load is controlled on a frequency bias basis which in turn determines load control on the system. Altogether there are five tie lines to the frequency regulating systems to the east.

Load information goes over the microwave system to the system load control center at Pine Bluff. All of this information is automatically added. The net power flow and direction of flow are determined by the equipment.

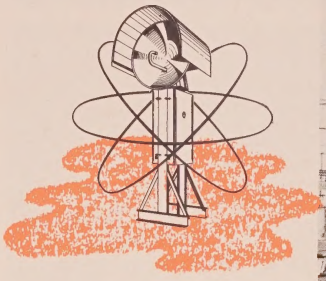
If the load is off the pre-determined schedule of power flow, automatic signals are sent to the various generating stations in the system to correct generation and bring power flow over the tie lines to the pre-determined schedule.

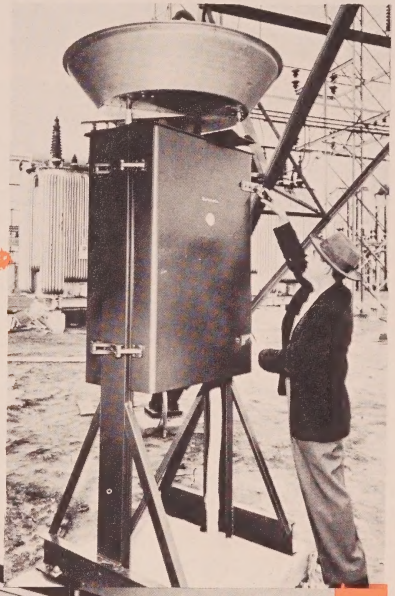
Division of this load to the various generating plants has also been pre-determined. Each picks up or drops off its proportionate share of the overall system load change.

TWO-WAY RADIO

In the North Louisiana Division of Louisiana Power & Light Co., trucks equipped with two-way radio cover areas beyond the range of the VHF base station at the West Monroe operating headquarters. The microwave system has solved this problem. Messages will soon go over the microwave system from West Monroe to Columbia where they will be rebroadcast by a second VHF base station. With the two VHF base station sites, the entire area will be adequately covered.

Long distance, point-to-point microwave relay systems are the answer to the extensive communications requirements of rapidly expanding power utilities. These systems provide reliable, uncongested communications channels to link dispatch points, interchanges, substations and generating plants.





Ray Barron, communications engineer for Arkansas Power & Light Co., checks out the equipment at the northern terminal of the system in Pine Bluff, Arkansas. This is the dispatching headquarters for the integrated power system.

TALKING BEATS WALKING

RADIO EARNS ITS KEEP IN TIME SAVED, EXTRA SAFETY AND IMPROVED SERVICE TO SHIPPERS

If engineers on Central of Georgia Railway trains operate as though they have eyes in the back of their heads, there's a good reason.

They keep in close touch with the rear of the trains via two-way radio, a working tool that is bringing new safety and convenience to American railroads.

The Central has integrated radio into all sorts of tasks where speedy, foolproof communications are required. The yards at Savannah, Macon, Columbus and Millen, Ga., and Coosa Pines, Ala., are radio-equipped. End-to-end radio service has been initiated on freights running between Savannah and Macon, Macon and Atlanta, Macon and Columbus, and Columbus and Birmingham.

Fifteen road engines now carry radio equipment, and sets for 10 more engines have been ordered. Motorola "HANDIE-TALKIE" portable radiophones are provided for cabooses, lodged within easy reach of the conductor and normally connected to an antenna on the caboose roof. These portables may be disconnected from the roof-top antenna and used with the whip antenna attached directly to the "HANDIE-TALKIE" unit when the set is hand-carried along the train.

Use of radio on freight trains saves a great deal of rough walking for train crews, as well as time, and this is especially appreciated at night or in bad weather. Radio is very useful in letting the engineer know when the rear of his train has cleared a switch or a crossing, or when some condition arises making it necessary to stop. If the conductor needs to have the train stopped, he can communicate directly with the engineer and tell him to stop, rather than risk pulling the train in two by opening the air valve in the caboose.

When one radio-equipped train passes another, each crew checks the other train for hot boxes or other conditions which require immediate attention. At the touch of a microphone button the engineer can be warned of troubles.

Every yard on the Central uses radio to meet its own particular problems. At Macon, one bottleneck was communication with Mead, where the Central and Southern maintain a transfer yard. Formerly Terminal Trainmaster J. C. Hydrick had to drive from the Macon yard office to Mead, check on number of loads and empties, and then drive back to Macon to inform the switch foreman what should be picked up. Now Hydrick uses a radio-equipped car to relay the information to the Macon yard office. "It really saves time," says Hydrick.

Radio helps the Central give better customer service, too. Says J. D. Wallis, superintendent of Atlanta terminals: "By being able to contact our switch engines quickly, regardless of where they are, we can keep informed as to how the day's work is progressing. This information is particularly useful when a customer who needs immediate service phones us to find out how soon we can get a switching engine to him. We simply radio our engine and make the necessary arrangements, usually while the customer holds the telephone line. Such special consideration, made possible by radio, really pays dividends."

Savannah Terminal Trainmaster N. S. Smith contrasted radio dispatching with the previous system. "In the old days, when a locomotive left the yard office, the only way we had of communicating with it was to telephone some company in the vicinity and ask if the switch engine was anywhere near, and would they call the engineer to the phone. Now when we want to contact an engineer, we simply pick up the microphone and call him. It speeds up operations all around."

The job of keeping the Central's ever-increasing radio facilities in top-notch shape falls to two full-time radiomen, George Vogel and Arthur Smith. In a well-equipped workroom at Macon, these two men periodically check all units. Sets on radio-equipped diesels brought into Macon for work are dismantled and thoroughly checked. Three layers of copper screen surround the workshop, keeping interference to a minimum while repairs are being made.

These men also make repairs and adjustments at the various base stations, as well as making the periodic measurements of frequency, modulation deviation and power output as required by the Federal Communications Commission for all radio transmitters.

Communications Superintendent T. E. Gates and his assistant, J. H. Walton, direct the Central's radio operations. Both men are high in their praise of radio as a supplement to existing communication facilities — and it is just that: a supplement which provides a means of increasing operating efficiency and an additional margin of safety to the extensive safety measures already being used in railroad operations.

Switching operations are much smoother, safer, faster and easier with the help of the Motorola radio system. Listen for a minute as Flagman A. M. Shores talks to Engineer A. C. Ryle of Train No. 38 through a switching operation at Gordon, Ga.

Shores, carrying a "HANDIE-TALKIE" portable set, presses the transmit button and immediately broadcasts this message to the engine cab:

"Ease on back, you've got six or seven car lengths, now five, now three, now one, easy . . . he's cut off, go ahead."

Good? It's better than having eyes in the back of your head.

Engineer E. L. Cooper carries on a radio conversation without taking his eyes off the road ahead. Handset hangs on rack shown at left.

J. D. Wallis, superintendent of Atlanta terminals, radios to the Industry yard office concerning movement of refrigerator cars.

Console beside Trainmaster J. C. Hydrick of Macon houses complete Motorola radio station—transmitter, receiver and power supplies.

Lockheed's giant B-47 on test flight over Stone Mountain near Atlanta, Georgia.

Both materials handling and security benefit by installation of two-way radio on overhead cranes, fork lift trucks, tractors, and plant protection cars, trucks and motorcycles. Portable radio units also prove their worth.

Overhead crane work output up 58%; utilization of all material handling vehicles up 35%; greater security, yet plant protection force cut 53%. This is the record of 2-way radio at the U. S. Government Aircraft Plant at Marietta, Georgia, operated by Lockheed Aircraft Corporation. Here is a prime example of how an industrial radio system provides better material handling and greater security per dollar.

With a floor space working area of approximately 70 acres, automobiles, bicycles, motor scooters and even roller skates are used for personnel transportation within the main building, designated as "B-1."

Material, delivered to the building by rail, truck and air, is moved within the building by radio-equipped materials handling vehicles. Eleven overhead cranes running on 39 miles of steel tracks lug anything from 12-ton B-47 wings to machine tools across the ceiling of the massive plant while 10 fork lifts, 6 tractors (tugs) and several trucks haul smaller items across the floor.

Two radio dispatch points are used for controlling these units. One, located on a balcony overlooking the main floor, dispatches the 11 overhead and outside cranes, and the other, on the main floor, dispatches the fork-lifts and tugs. Trucks are dispatched from the nearby B-8 building.

On the back of each crane cab, visible to all below, is a sign which states in bold, red letters, "For Service, Call 3033." By dialing that number, a supervisor who wishes to have a large or heavy piece of material moved can talk to the overhead crane radio dispatcher. The dispatcher writes down the necessary information about location and items to be moved, presses the radio microphone button and gives the information to the crane crew he has designated for the job. If it is a rush job, he can quickly check with several crane crews to determine which can best handle the job.

Until 2-way radios were installed in the cabs of the overhead cranes, three dispatchers were needed and dispatching was done manually. That is, the dispatcher tracked down the crane on foot and by means of hand signals or shouting told the operator in the cab what his next job was. Delays averaged about an hour. In this manner, 14 overhead crane crews, each crew including the crane operator and two riggers, handled an average of 1400 jobs per week. The equipment and manpower utilization figure averaged 50%.

Now, with a radio dispatching system, eleven crane crews are

UPS EFFICIENCY AT LOCKHEED

handling an average of 3300 jobs per week with a utilization figure on the order of 85%. In other words, radio dispatching enables them to handle more than twice as many jobs with fewer crews and only one dispatcher.

According to E. R. Mabery, building B-1 transportation supervisor, it would have been impossible to handle the stepped up work load without the 2-way radio system designed and installed by Motorola. With the former dispatching system, to double the work load would have meant more than doubling the number of crane crews, an impractical task from a space viewpoint. The handling capacity of smaller vehicles on the floor of the building has also been doubled. Once the fork lifts, trucks and tugs start out in the morning, they remain out until the end of the day. Direct radio contact is maintained at all times with no vehicle "lost" to the dispatcher. This is a far cry from the days when each vehicle had to return to the dispatcher's office after each job, while the dispatcher hunted feverishly for someone to handle a rush order.

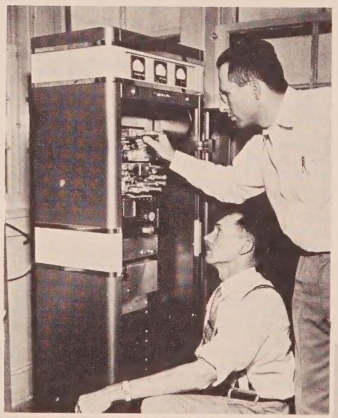
Dispatchers also control by radio, two yard cranes, one truck crane and two special airplane towing vehicles.

Tight security at Lockheed's Marietta Division is essential, points out James V. Carmichael, a director of the Lockheed Aircraft Corporation. As an aid in enforcing security measures, radio units have been installed in all plant protection cars, trucks and motorcycles. Before the radio system was installed, a force of 216 uniformed patrolmen and 100 firemen was necessary. Because of the greater coordination now possible and because no patrol car or fire truck is out of reach of the police and fire radio dispatchers, the force was cut to 93 uniformed guards and 54 firemen. According to Plant Protection Manager W. J. Willcox, plant security is even better now than it was with the larger force.

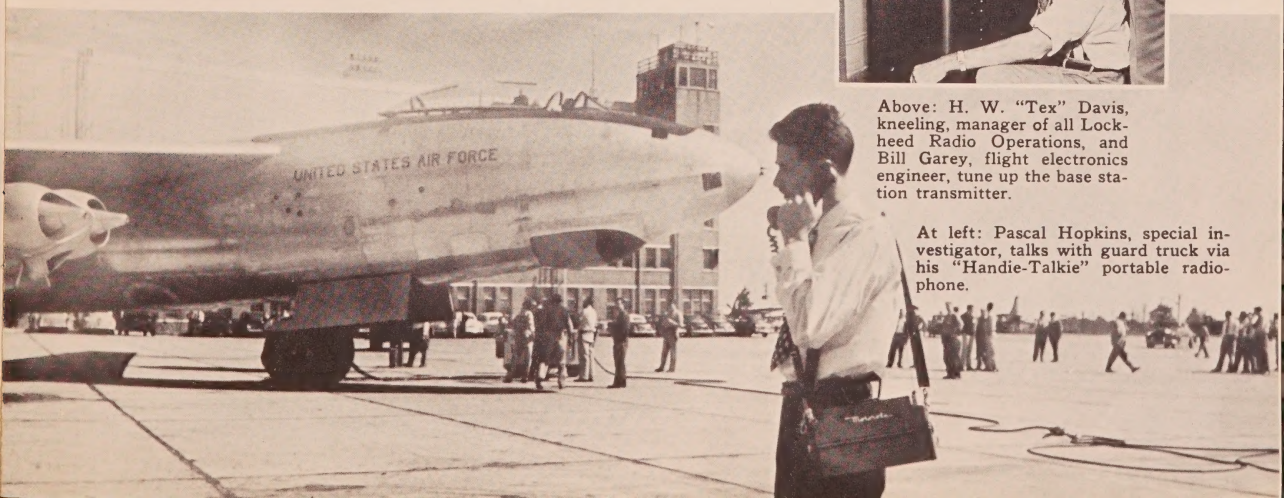
"Handie-Talkie" radiophones have also been of value to Lockheed. Several incidents happened after Lockheed acquired the units which proved their value and more than returned their cost by the savings they made possible.

Each B-47 is thoroughly tested by Lockheed before it is delivered to the Air Force. Officials cite instances where "Handie-Talkie" units have filled in for aircraft-to-control-tower communications which were disrupted by a power failure. An ILS (instrument landing system) was recently located and installed with the aid of the "Handie-Talkie" units. Without them, the job would have been almost impossible.

To the Lockheed Aircraft Corporation, the 2-way radio system has indeed been very valuable from both an economic and coordinative standpoint. Their Motorola radio system is giving them more security and faster coordination for handling materials per dollar.



Above: H. W. "Tex" Davis, kneeling, manager of all Lockheed Radio Operations, and Bill Garey, flight electronics engineer, tune up the base station transmitter.



At left: Pascal Hopkins, special investigator, talks with guard truck via his "Handie-Talkie" portable radiophone.

new research laboratory for military electronics added to Motorola family

DEDICATE NEW Motorola RESEARCH LABORATORY

An experienced team of forty scientists and engineers have recently joined the ever-expanding Motorola family and will provide the nucleus for the company's new research laboratory in Riverside, California. According to Daniel E. Noble, vice president in charge of the company's Communications and Electronics Division, the new laboratory will be devoted primarily to work in the field of military electronics. John Byrne, former Director of Engineering of the company's Communications and Electronics Division, will manage the laboratory.

The new facility was formally dedicated in ceremonies attended by officials of Motorola, laboratory employees, representatives of the armed services and the community. In a dedication message, Paul V. Galvin, Motorola president, termed the laboratory of significance for its potential influence on the whole area of Motorola's work in military electronics and its influence in bettering coordination of military and industrial efforts through the procedures of operations research and dynamic systems analysis.

"National defense is as much the business of an industrial organization as it is the military," Mr. Galvin said. "It is in the spirit of accepting our obligation and our responsibility that we are searching for ways and means of improving the effectiveness of our work with the military establishment."

STAFF EXPERIENCE

The nucleus of the research staff includes physicists, mathematicians, electronic engineers, mechanical engineers and aerodynamics specialists. This team has been continuously engaged in guided-missile research and development since 1941. They were formerly employed by the National Bureau of Standards and comprised the major portion of the senior technical staff of the NBS missile development group built up during World War II. The group has distinguished itself in the past making outstanding and continuous contributions to the design and development of air-to-air, air-to-surface and surface-to-surface guided missiles. Significant contributions were also made to the development and engineering of proximity fuses.

Initially, the laboratory will employ approximately 200 people.

FACILITIES

Home of the research staff is a new 22,000 square foot air conditioned laboratory situated on a

14-acre tract of land in Riverside, California—less than 50 miles from metropolitan Los Angeles. The laboratory is ideally located both in regard to dispersal of strategic industry and closeness to military missile centers on the West Coast.

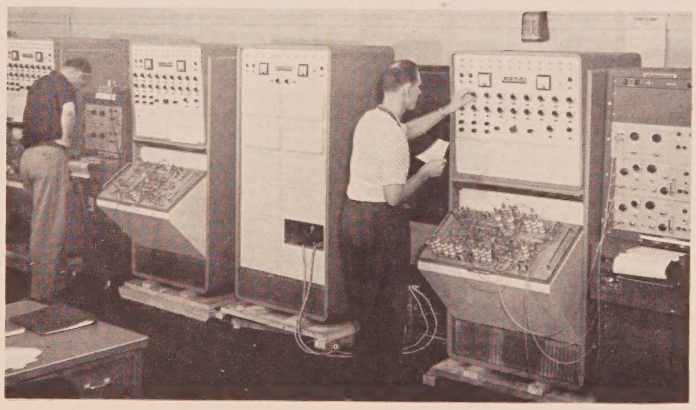
The new laboratory is equipped with the most modern tools available in the fields of servo, audio, video, RF and microwave circuitry. In addition, the laboratory boasts a new analog computer—an essential tool for the design and analysis of complex weapons systems.

In addition to the new laboratory in Riverside, Motorola has three other engineering departments whose work is primarily devoted to military electronics. Two of the military engineering groups are in Chicago, and the third in Phoenix, Arizona. The work in all four military laboratories is closely correlated with the manufacturing procedures used in the production plants, and the equipment production prototypes developed in the laboratories can be routed into mass production in one or all of eight Motorola plants without delay or lost motion.

The four military electronics laboratories are coordinated and complementary, with each providing specialized services to the others, and with all contributing to the vast Motorola engineering pool. This sustained emphasis upon engineering, demonstrated by the work of these diversified laboratory organizations, reflects the Motorola conviction that any company's position in the military electronic field must be earned by significant and continuous contributions to research and engineering.

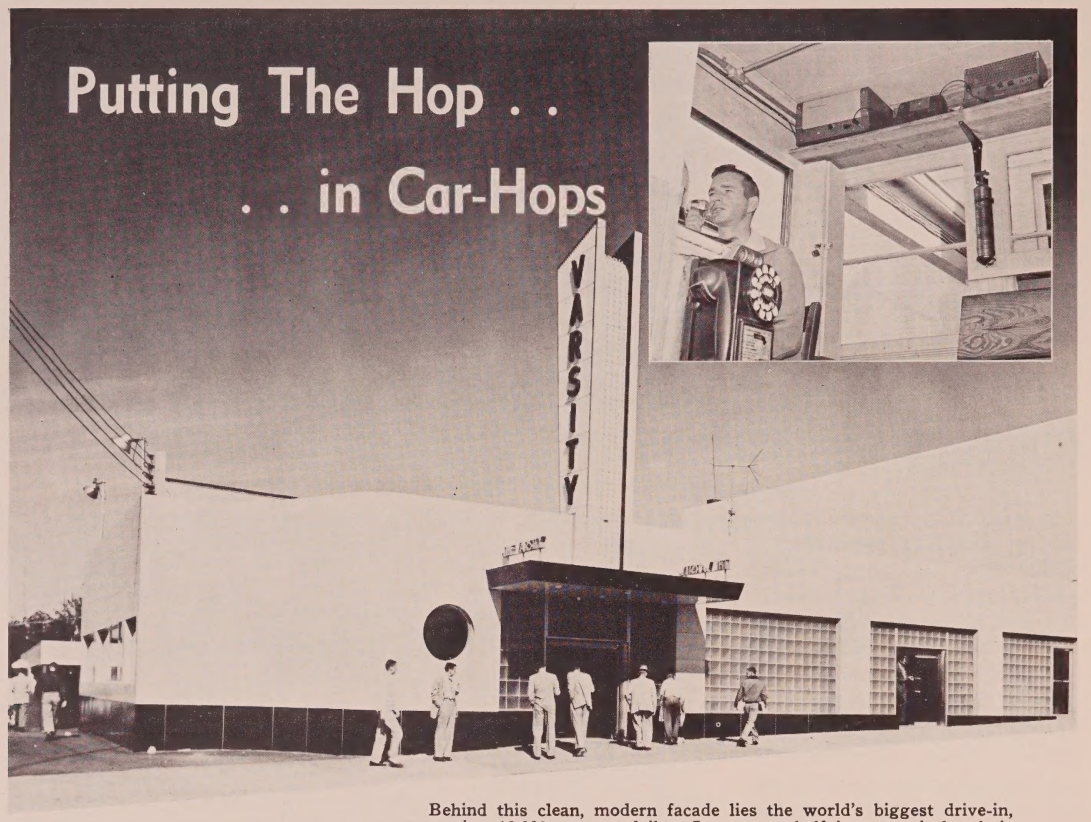
Daniel E. Noble, (left) vice president in charge of Motorola's Communications and Electronics Division, and Paul V. Galvin, Motorola's president, confer with Captain F. C. Manville, USN, at the recent dedication ceremony.

Motorola's new research laboratory is located in Riverside, California, only a short distance from metropolitan Los Angeles.

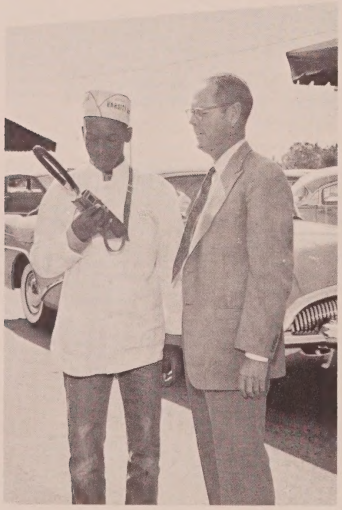


Modern, up-to-date equipment at the laboratory includes an analog computer to be used in the design and analysis of complex weapons systems.

Putting The Hop . . . . in Car-Hops



Behind this clean, modern facade lies the world's biggest drive-in, serving 10,000 patrons daily. Inset: on shelf in spotter's booth is radio receiver for The Varsity's unique car-hop paging system.



Owner Frank Gordy checks out a spotter in use of Motorola portable "Handie-Micro-Talkie" transmitter. Three spotters direct the 75 to 100 curb boys who provide tray service to 210 cars at a time.

A clock-watching customer at The Varsity drive-in restaurant in Atlanta, Ga., recently timed how fast he could get three dozen hamburgers and hotdogs. Total time from order to delivery: 4 minutes.

This speedy service is a major reason why Georgia folks consistently steer their cars into this world's biggest drive-in.

Fast service doesn't just happen. It takes a squad of 75 to 100 curb boys to cover the 210-car parking area. These lads work for tips and they move fast when a customer wants service.

Directing the car-hops are three spotters carrying Motorola "Handie-Micro-Talkie" portable radio transmitters. The spotters roam the parking lot continuously and at the first blink of a headlight or honk of a horn they radio the car number to a receiver inside The Varsity. Spotters' voices are fed into the public address system and come booming back to the car-hops. One call puts a car-hop on his feet and running.

Varsity Owner Frank Gordy added the battery-powered transmitters (which are, in effect, "cordless" microphones for the loudspeaker system) when the spotting task became too cumbersome for a lone supervisor working from an elevated vantage point.

It's an unusual use for radio—but Frank Gordy runs an unusual food business. Where else can you find a drive-in serving 10,000 patrons a day with a yearly gross well over $1,000,000, and not one item on the menu priced at more than 30c?

A man, a machine, and a 2-way Motorola = new production records

RADIO PACES IN-PLANT TRUCKS

"Come in, 18."

"Bill, stop at Fuel Pumps on your way back from Plant 6 and pick up a load of zinc for ornamental die casting."

These and similar messages go floating through the airwaves at AC Spark Plug's busy plant on Dort Highway, Flint, Mich., each work day. It's the voice of AC's two-way radio system, used to expedite miscellaneous intra-factory material handling.

A base station transmitter-receiver housed in a box about the width of a typewriter is the nerve center of this General Motors Division's communications system. Through it the dispatcher guides the work of eight fork lift trucks throughout the extensive plant.

Driver Thomas W. Boris checks in by radio with AC's material handling office as he pilots his fork lift truck from job to job in the huge factory at Flint, Mich.

Two other mobile units are mounted on AC's fire trucks, giving the emergency vehicles instantaneous contact with the dispatcher as well as with the fork lift operators.

AC's Motorola radio system works like this:

A foreman needs a load of stock moved. He calls the dispatching office. The dispatcher, knowing at all times in what area the radio trucks are working, calls the truck closest to the foreman's area. Generally in a matter of minutes the foreman has a truck at his disposal.

Use of the radio system greatly reduces the driving time for all drivers. At the same time, if a truck is moving from one area to another, it will generally be loaded.

"We not only find it speeds up deliveries," says Joseph Swartz, first shift dispatcher, "but the drivers couldn't be convinced now that they could get along without the two-way radios. It saves them an awful lot of useless riding."

Reports Eddie Barth, foreman and a veteran of 31 years in the material handling field: "I'm convinced these radio units are about the best thing that has come along in plant trucking."

RADIO COMMUNICATIONS SERVICE Co
Motorola
TWO WAY - QUICK CALL RADIO - TWO WAY
55 MOBILE 1 BASE STATION 3 MONITORS
FOR
BOARD OF WATER TRUSTEES
SAN ANTONIO, TEXAS

Standing before stacks of the empty cartons from Motorola mobile radios being installed for the San Antonio Board of Water Trustees are Richard R. Hayes, right, owner of Radio Communications Service Company, and Technician Ray Kaiser. Hayes' firm, an authorized Motorola Service Station, also will maintain the base station and 55 mobile units.

SELECT DESIRED VEHICLES BY MEANS OF "QUIK-CALL"

There's very little possibility a department truck driver will miss a call put on the air for him by the Water Department dispatcher in San Antonio, Texas.

The Board of Water Trustees has installed a Motorola base station and 55 mobile units incorporating "Quik-Call" selective signaling which alerts the driver by blowing the horn, lighting a lamp on the control head and switching on the radio loudspeaker.

Use of the "Quik-Call" accessory permits the base station to direct a message to only one vehicle or to a selected group of mobiles. For example, 10 cars and trucks used by supervisors and key employees are alerted simultaneously at the press of a group-call button. Receivers in all other Water Department vehicles remain silent until the dispatcher sounds the code for their particular vehicle.

By adding this selective signaling, Water Board officials eliminate the need for drivers constantly monitoring all transmissions which do not concern them. A driver hears only messages directed to him. In addition, he can switch on the "horn alert" circuit when he leaves his truck, and any messages directed to him will cause his horn to blow for a period of seven seconds, thus warning him to return to his truck for the message.

In addition to the 55 mobile units, the Water Department has installed monitor receivers at three main pumping stations. The 60-watt base station, remotely controlled, is installed beneath a city water tank which doubles as the antenna tower on one of the highest elevations in San Antonio.

The simplex (single frequency) radio system, installed and maintained by Radio Communications Service Company, Motorola's franchised Service Station, has a range exceeding 30 miles and effectively blankets the entire service area of the Board of Water Trustees.

The New Age Of The Horse

During test maneuvers, Harford county horsemen equipped with Motorola "HANDIE-TALKIE" radiophones aid Forester Paul Seward at a traffic jam to show what part horses would play in case of an atom bomb attack on Baltimore.

It looks as though the atom bomb and its successors are setting civilization back.

In Harford county, Maryland, a group of horse owners decided that, if Baltimore were bombed, men on horseback would be able to maneuver better than men in cars.

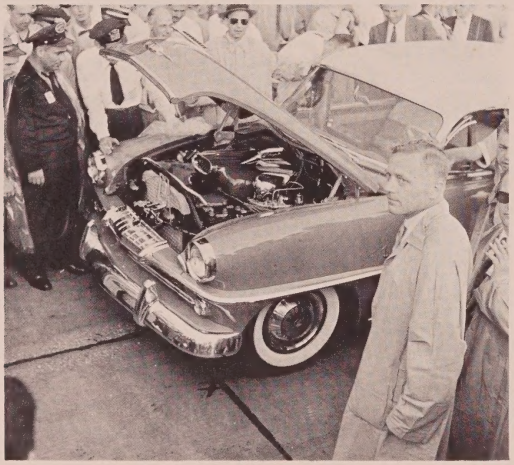
They could jump over or ride around fallen trees or other debris that might clog the roads. They would not be dependent upon roads that might be jammed with automobiles. With telephone lines out and roads jammed, they would provide the fastest messenger service. And, by having Motorola portable two-way "HANDIE-TALKIE" radiophones, they could relay messages, call for help and coordinate rescue operations.

Civil Defense workers under the direction of Paul Seward, a State Forestry and Park Service officer, met with a group of riders and set up maneuvers to acquaint the horsemen with tasks they might be called upon to perform.

Since refugees from a bombed city would need shelter, Jean Royston canvasses farms for billets and then radios word back.

Chrysler's turbine car in its first public showing.

TURBINE CAR IN FIRST SHOWING



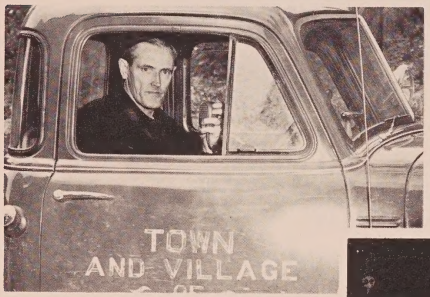
Above: An interested group of spectators examines the turbine engine of the new test car. At right is George J. Huebner, Jr., executive engineer in charge of research, who was one of the test drivers.

Right: Miss Mary Lou Chapman of Chrysler Corporation shows how cool the exhaust from the turbine car is.

Chrysler Corporation recently celebrated the grand opening of their new Engineering Proving Grounds by showing their turbine car to the public for the first time. The car was equipped with Motorola two-way radio so drivers could relay their reactions to the crowd that jammed the grandstands. The base station receiver that picked up comments from the mobile receiver rebroadcast it through the public address system.

"UNIFIED COMMUNICATIONS"

The value of a municipal radio communications system is often enhanced by having a number of departments operating on the same frequency. An example of "unified communications" is the two-way radio system of Springfield, Vt., which has been described as one of the most efficient on the Eastern Seaboard. As illustrated below, the police department, fire department, superintendent of streets, ambulances, hospital, CAP aerial units, and other nearby police departments have a system of intercommunications ideally suited for use in extreme disasters as well as everyday emergencies.



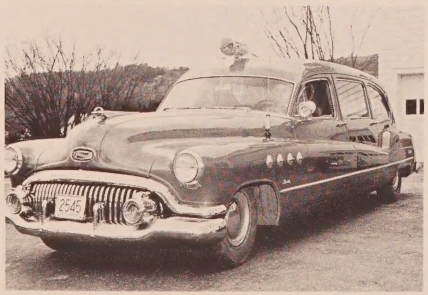
SUPT. OF STREETS

FIRE

POLICE HEADQUARTERS

PLANE

POLICE



AMBULANCE

HOSPITAL

RADIO COVERS

When heavy rains posed a flood threat recently to Hammond, Ind., radio stepped in to co-ordinate rescue and rehabilitation efforts, and simultaneously to give listeners full news coverage.

Hammond's Radio Station WJOB equipped its reporters with Motorola "HANDIE-TALKIE" portable radiophones, enabling them to broadcast from remote locations. At the same time WJOB's affiliated message service, South Shore Radio Telephone, Inc., pressed 35 mobile units into relief efforts. More than 700 flood calls were aired during the station's 137-hour "weather watch."

Reporter Jack Highberger dons hip boots and portable Packset for remote newscasts.

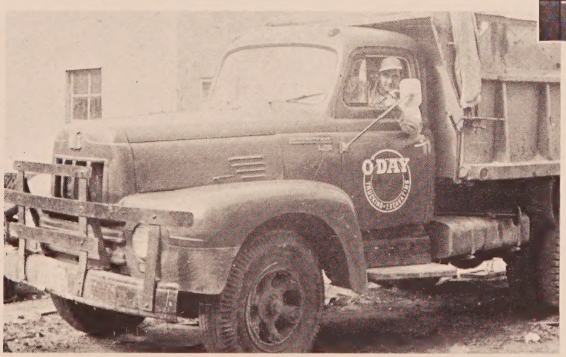
Above: Mobile radios guide the effort of dump trucks hauling sand for temporary fill.

Right: From vantage point on temporary dike in Hammond, Reporters Highberger and Len Ellis tape-record flood damage story.

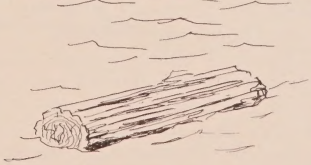
S A FLOOD

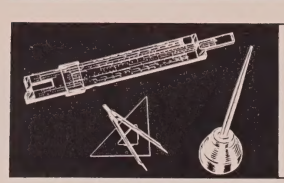
Reporters went along with rescue workers to gather first-hand facts on flood.

Above: Selective signalling buttons on Dispatcher Doris Werblo's desk route messages to a single mobile receiver, ease monitoring task.

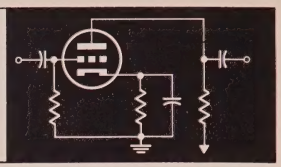


Left: Radio-equipped sand truck of O'Day Trucking, Highland, Ind., served as temporary control point during dike building.



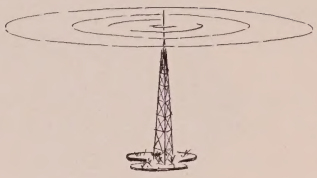


Technical Notes Section



RADIO COVERAGE

How far can two-way radio reach for reliable communications? The maximum limit is generally considered to be the radio horizon, but, there are other contributing factors.



From an engineering standpoint, it is technically sound to state that reliable communications can be maintained within a radius in excess of 18 miles around a 160 mc. 60 watt base station with a 100 foot antenna tower over normal rolling terrain. Because this generalization is based on a number of assumptions, it is invalid for any variation from normal expectations. On the other hand, many systems are operating today with ranges of two to three times this distance. Hence, it would be erroneous to state that the coverage is strictly limited to 18 miles for the above case. Any experienced engineer or technician will be able to hazard a guess as to range for a specific installation, but it takes a more comprehensive survey to arrive at a figure which the engineer is willing to guarantee.

FIELD TESTS

One method of arriving at a reasonably correct range estimate is in comparison of the proposed system to like systems operating under the same conditions. A second method is to actually set up a test installation, simulating the proposed installation, for the purpose of accumulating test data. If the test installation is a duplicate of the final installation, and if a sufficient number of tests are made, it is obvious that the greatest accuracy in prediction can be obtained. For convenience in data evaluation the collected data can be plotted in the form of signal strength contours on any standard map.

Frequently it is technically and economically impractical to conduct a full-scale survey. In such cases where an abbreviated survey is inadequate, an engineering study on paper is employed.

PROPAGATION

VHF radio, for the most part, behaves like light. The radio beam travels in a straight line but is subject to reflection, refraction and diffraction. The local conditions determine what the maximum predicted range will be. Among the factors which must be included in an engineering analysis are: topography, geology, man-made and natural obstacles, foliage, transmitter power, receiver sensitivity, antenna height, antenna gain, antenna directivity, transmission line losses, noise, interfering signals and space attenuation. Additional factors such as "skip" must be considered although not necessarily included in calculations.

RADIO HORIZON

As a basis for calculations, transmitter effective radiated power (chassis output plus antenna gain less losses) and effective receiver sensitivity (chassis sensitivity for reliable communications plus antenna gain less losses) must be used. As an example, a transmitter power of +18 dbw. (60 watts) and a receiver sensitivity of −138 dbw. (1 microvolt) will permit propagation losses up to 156 db. while retaining reliable communications. Free-space attenuation charts and tables are supplemented by data on relative topography and radio horizon to correlate propagation losses to range.

Diffraction tends to extend the radio horizon beyond the visual horizon. Accumulated experience has shown that at the lower frequencies a realistic range figure is obtained by using a theoretical earth radius which is 133% of the true earth radius. At higher frequencies (450 mc. and above), this 4/3 earth radius is no longer as accurate and "true" earth radius plus Fresnel zone charts are used.

PROFILE

Using a graphical form which presents height above ground on a vertical scale and earth curvature on a curved horizontal distance scale, a profile of the radio horizon can be easily plotted. This pictorial representation of the corrected line-of-sight path shows clearly not only the radio horizon, but the "shadow" effects of natural and man-made objects as well. From a number of these profile charts for important radials from the transmitter site, data can be transferred to a signal strength contour plot on any common map. Even though this type of analysis is reasonably accurate and conservatively correct, it cannot and does not include all of the effects of natural

phenomena which accompany VHF radio propagation.

PROPAGATION EFFECTS

Radio signals, particularly at lower frequencies, can be reflected from a layer of ionized air in the upper atmosphere and "bounced" back to earth hundreds or thousands of miles away. While this "skip" effect goes through periodic cycles, it is constantly changing and cannot be relied upon to provide dependable communications. Actually, in an engineering evaluation, "skip" may be considered in a negative sense as an interference possibility.

"Forward scattering" wherein high powered transmitters and highly directive antennas beam signals beyond the normal radio horizon is currently in the stage of investigation and may prove useful in the future. Similarly, higher than normally expected coverage behind high sharp ("knife-edge") obstacles is undergoing study.

Reflections from solid objects can both add to and subtract from expected range and are difficult, if not impossible, to predict on paper. In congested cities, the multiple reflections from buildings, particularly at the higher frequencies, help to "fill in" the coverage gaps behind buildings and under bridges out of the line-of-sight path. In the canyons of mountainous areas it has been found that reflections "bouncing" between the canyon walls can materially increase the range beyond expected line-of-sight paths. However when two reflections arrive at a point via two separate paths, range is affected in other ways. Signals in phase with each other are additive but out-of-phase signals can produce cancellation. Hence, in any system which has multi-path multiple reflections, some "dead" spots can be expected regardless of the equipment used.

Foliage, particularly damp or wet leaves on trees, will tend to absorb radio signals. The higher frequencies will suffer the greatest attenuation. Thus, it is to be expected that in densely wooded areas, coverage will be greater in fall and winter than in spring and summer.

Interfering signals which fall in the receiver passband, regardless of their origin, must be considered in the evaluation. This includes the spurious and harmonic output of nearby transmitters, receiver spurious and image response as well as intermodulation and desensitization.

It must also be remembered that the lower frequencies have antennas which are physically longer for a given electrical wave length and hence, intercept more of the electric field (microvolts per meter). For a given field strength, the lower frequency antennas induce more microvolts of signal into the receiver. This coupled with the fact that it is possible to build more sensitive receivers at the lower frequencies, contributes substantially toward the longer range obtained on the lower frequency VHF bands.

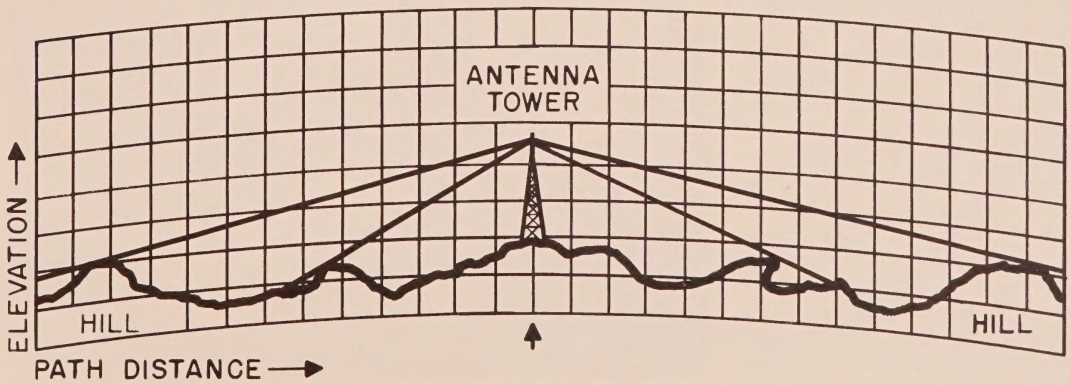
POWER

Transmitter power output and communication range are not directly proportional in the typical VHF system. The variable effects of terrain signal absorption especially beyond "line-of-sight" distance from the base station essentially destroys the inverse square law of signal attenuation achieved in free space.

All of the preceding statements have been directed at base-to-mobile communications. It must be noted that the communications range between mobile or portable units will necessarily be less because of generally lower power and lower antenna heights.

SUMMARY

It should be obvious that it is impossible to point to a two-way radio unit and make an unqualified statement that the range is 10 miles—or 20, or 30, or 50. Too much depends on the specific location and application. As stated in the opening paragraph, the maximum range is generally considered to be the radio horizon, but, there are other contributing factors.



Sample Profile Chart Pictorially Depicts Radio Range

SERVICE HINTS and SHOP NOTES

RAILROAD CONVERSION

Two conversion kits have been made available to provide supplementary B+ fusing in the PA-7279 Series Railroad 117 VAC Power Supply Chassis. This additional protection for circuit components can easily be added to early production chassis. For model PA-7279 chassis and early PA-7279-A chassis (with the 15/25 mf. dual electrolytic capacitor under the chassis) can be modified with kit No. SK9428. Later model PA-7279-A chassis (with the 15/25 mf. dual electrolytic capacitor above the chassis) can be modified with kit No. SK9429. Full installation instructions are supplied with the kit.

IGNITION NOISE

With ever-increasing compression ratios and higher ignition voltages in modern automobiles, the countering of ignition impulse noise in radio receivers becomes more of a problem. To assist the radio technician in resolving this problem, Motorola has made an additional ignition noise reduction kit available. The TK294 has been designed specifically for the 1954 Ford "Interceptor", an "extra-power" model used by many police organizations. The kit may also be used on all other 1954 Ford V8 models and consists of by-pass capacitors, shield braid, and additional items for reducing and cancelling ignition noise pulses.

AGC

Motorola receivers have, for many years, incorporated a delayed automatic gain control circuit to maintain optimum gain and provide maximum protection from desensitization and intermodulation interference. Current mobile receiver shipments include this circuit as an option. All circuit components are present and all circuit connections are made. However, the circuit is shorted to ground with a jumper connection. Because shorting out the AGC aids to a degree in reducing ignition noise interference, the receiver may normally be used as shipped for best operation. Normal ignition noise suppression measures should, however, be taken. For those cases possibly subject to desensitization or intermodulation interference, the jumper can be clipped out and the AGC circuit will function normally.

TRACTOR RADIO

Communications Engineer Al Vendt of the Louisiana Forestry Commission, with the assistance of Radio Engineers George Waggoner and R. S. Bennett, has developed a unique radio system for use in forest firefighting operations.

Crawler type tractors, so necessary in the firefighting opera-

Motorola radio installation on the fender of a John Deere crawler tractor of the Louisiana Forestry Commission.

tions, were previously "on their own" after leaving the truck which transported the tractors to the scene. The tractor operator was forced to return to the truck to contact a towerman or other Commission two-way radio station via the truck radio equipment. Now, however, results have been so encouraging on the new installation that at last report, 28 tractors have been radio equipped.

The installation is made in 10 gage steel weatherproof and snagproof housings which are virtually indestructible. Dual cable connections are provided which permit the radio set to be operated from either the truck cab or the tractor. When being carried on the truck, the radio draws its power from the truck battery and is controlled from the truck cab. When the tractor is unloaded, the truck power cables are disconnected and the radio, reconnected to the tractor battery, is controlled from the tractor operator's seat. A weatherproof directional speaker on the tractor is used to overcome the noise of the tractor in operation. The tractor crew is thus never out of radio contact whether riding in the truck or on the tractor.

Al Vendt has added another touch to the system as a safeguard. In the rush of a fire emergency, the crew can't forget to unplug the truck cable and plug in the tractor cable. The cables are wired such that the tractor will not start unless the tractor radio cable is plugged in. Thus, there can be no snapped cables to cut off radio communications.

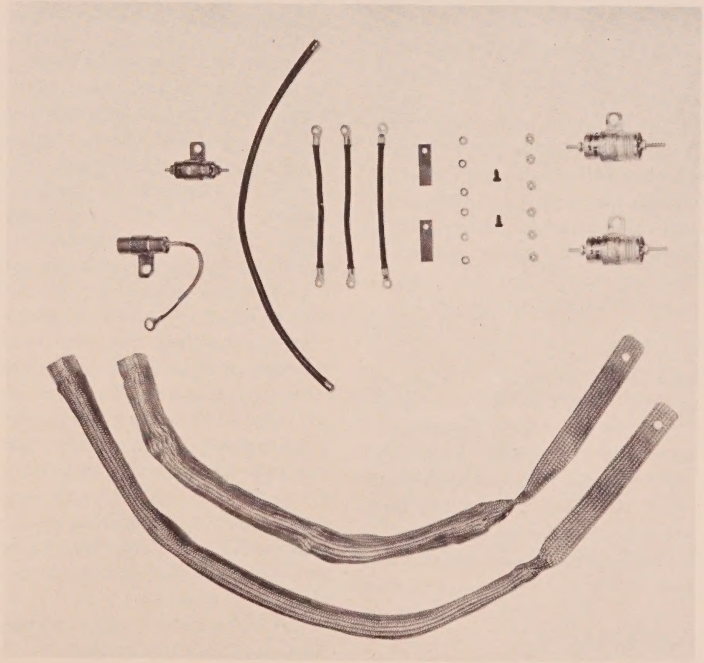
MODEL NUMBERS

To the individual radio user with only one or two makes or models of equipment in service, model numbers are, in general, of no great significance. However, when exact parts, service, performance or modification information is required from the manufacturer, the model number is not only significant, it is indispensible. Incomplete, incorrect or missing model nomenclature generates possibly inapplicable information, incomplete answers or probably needless delay while the additional information necessary is requested from and supplied by the user.

To pass on all the latest technical advances as rapidly as possible to all of its customers and to fulfill the wide variety of demands, for equipment for every application, Motorola has had thousands of models of two-way radio equipment through the many years of its existence. While groups of models may have identical or closely similar chassis within the model, it is not always possible to provide exact details from a model "family" description.

Hence, the fastest, most correct answers to inquiries for parts, service, performance or modification information, include the **full** model number including all suffix letters and numbers. If the information desired is on a specific chassis, include full chassis nomenclature including all suffix letters and numbers. Model numbers are to be found on the equipment nameplate. Chassis numbers may be on chassis nameplates or stamped on the top of or underneath chassis. It is also important in many cases to specify modifications which have been made on the equipment after installation.

To summarize, because of both major and minor model variations which can affect the information supplied, include full and complete model nomenclature in all requests.



The TK294 Ignition Noise Reduction Kit is specifically designed for the 1954 Ford "Interceptor".

MARINE RADIO

F.C.C. rules going into effect on January 1, 1955 require that all ships using VHF radiotelephone equipment (156 mc.). except for marine-utility (portable low power equipment), must be equipped to transmit and receive on the safety and calling channel, the ship-to-ship channel and a ship-to-shore channel. The ship-to-shore channel can be a working channel, a public correspondence channel or a Coast Guard channel. While these requirements can be met by a combination of 1- and 2-channel units, Motorola has developed a basic 4-channel radio package which can be used for either 3-channel or 4-channel operation.

RADIO SET

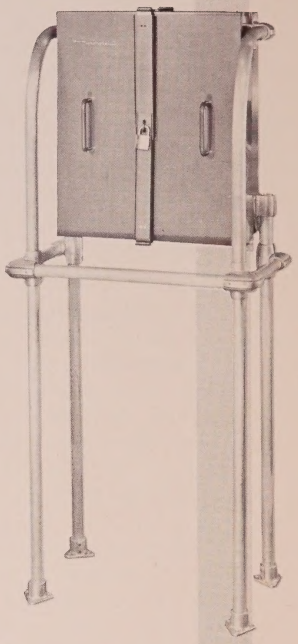
The radio set includes the same basic transmitter and receiver chassis used in the "43G" series of 144-174 mc. mobile radio units. A 117 volt 60 cycle power supply and the transmitter and receiver chassis are included in the standard Motorola 15 inch mobile housing. The transmitter produces at least 20 watts RF output on any frequency within the 156.3-157.4 mc. marine radiotelephone band. The Uni-Channel receiver with a selectivity of −100 db. at ±32 kc. has a sensitivity of better than 1.0 microvolt on any channel within the same band. While designed for the 1.1 mc. wide marine radio telephone band, this unit can also be used for other multi-channel applications within the bandwidth limitations.

CONTROL UNIT

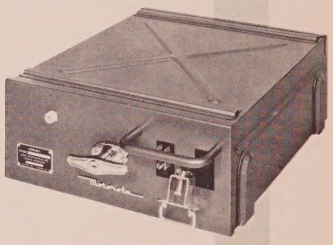
The weatherproof control unit, cable connected to the radio set, mounts wherever control is required, permitting mounting of the radio set and the control head both in the best location for the specific installation. On the control head are included the usual volume and squelch controls plus a pilot lamp dimmer control and a channel selector switch. Automatic reverting is provided which returns the transmitter and the receiver to the safety and calling channel whenever the handset is replaced on its hook. A lamp for the safety and calling channel is illuminated whenever the channel is being used for either transmitting or receiving. A second lamp, illuminates the channel selector when any other channel has been selected. And, of course, there is a "transmit" indicator lamp.

ACCESSORIES

A complete line of accessories for this unit has been made available. The cable kit between the radio set and the control head is supplied at the correct length for a specific installation. A modified version of the Motorola "Isoplane" antenna, specifically designed for marine installations, as well as other standard antennas can be used. A new weatherproof housing provides all-weather protection for the radio set regardless of mounting place. A cable entrance kit for the weatherproof housing, mounting brackets and a shock mounting kit are also available. A universal mounting kit (stanchions) for bulkhead, deck or overhead radio set mounting has also been designed for this unit. For shipboard installations with unregulated DC voltage supplies, DC to 117 VAC voltage regulating inverters can be supplied.



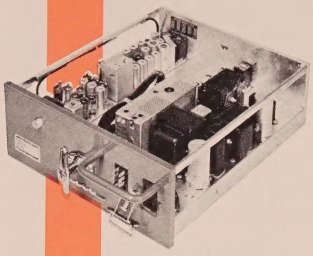
MARINE RADIO WITH WEATHERPROOF HOUSING AND UNIVERSAL MOUNTING KIT



MARINE RADIO UNIT

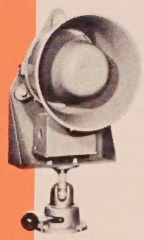
CONTROL UNIT

NEW PRODUCTS

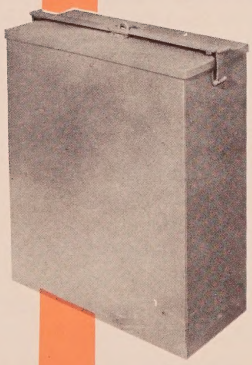


FIRE-UTILITY RADIO UNIT

NOISE CANCELLING MICROPHONE AND CONTROL HEAD



WEATHERPROOF SPEAKER



WEATHERPROOF HOUSING

FOR DEPENDABLE RECEPTION IN NOISY AREAS . . .

FIRE—UTILITY RADIO

Engine and wind noise in a fire engine enroute to a fire, the mechanical noise surrounding a construction site and the distance between a utility crew and its vehicle often require considerably more than the normal 1 to 1.5 watts radio output to make the two-way radio system realize its full potential usefulness. The receiver audio output must be adequate to overcome both noise and distance.

For this purpose, Motorola has developed the Fire-Utility mobile radio unit. The F41G series in the 25-54 mc. range and the F43G series in the 144-174 mc. range are complete single-package radio-amplifier units. Utilizing the standard Motorola 15" mobile housing, the F41G series are rated at 25-30 watts RF power output and the F43G series are rated at 20-25 watts RF output, both series rated at 10 watts audio output.

6/12 VOLT OPERATION

Leading the trend of the times, the Fire-Utility radio unit is designed for 6/12 volt operation. The same radio set operates interchangeably from a 6 volt or 12 volt power cable without any modifications whatsoever to the radio set. Simple modifications convert a 6 volt cable to 12 volt operation if the 6 volt cable is ever re-installed in a 12 volt vehicle.

ACCESSORIES

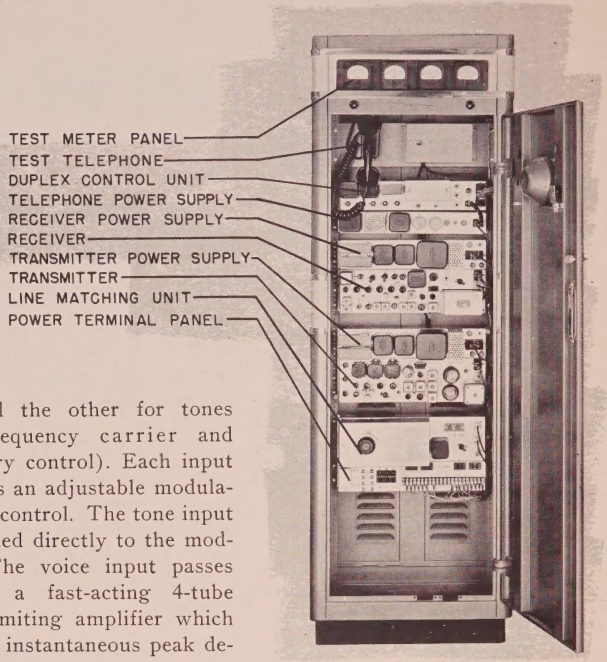
Standard accessories for all models include the power and control cables, the control head and noise cancelling microphone, a weatherproof (10 watt) speaker and antenna (spring base "whip" for 25-54 mc. or coaxial dipole or rooftop "whip" for 144-174 mc.). An additional conventional speaker for a firewall mounting, a swivel base for the weatherproof speaker, a weatherproof housing and a shock mounting kit are optional accessories.

APPLICATION

Wherever high receiver audio output level is required, this unit finds its place. A single compact package serves the needs of fire-fighting applications, heavy construction, public utilities and many other similar uses in both governmental services and private industry.

Through use of the "Handie-Micro-Talkie" transmitter (144-174 mc.) or a "Handie-Talkie" portable radio unit, orders can be transmitted to the working force via the radio system from virtually any nearby location. A fire lieutenant inside a burning building can verbally direct outside operations. A foreman in an excavation can direct a crew at its edge. A supervisor on a power line construction project can direct crews at various points on the line. The portable radio unit thus acts as a wireless microphone, capable of use anywhere within range. And, this compact mobile radio unit retains the full capabilities of mobile-to-mobile and base-to-mobile radio communications.

POWER LINE CARRIER EQUIPMENT DESIGN



Motorola power line carrier (reference article in Sept.-Oct. Newsgram) has all the inherent advantages of FM including superior signal-to-noise ratio, constant audio output through wide variations in power line attenuation characteristics, and improved performance with less output power (less interference to other channels). Narrow-band frequency-modulation, low transmitter spurious and harmonic output, and attainment of **all** selectivity before amplification permit extremely close carrier channel spacing. Operation from AC primary power requires low input power and permits simplicity of circuit design. All equipment metering circuits are compensated for single-scale meter indications by the test meter panel. A metering selector switch connects all metering circuits to a single jack on each chassis.

There are three types of power line carrier assemblies, each for a specific type of operation: (1) manual simplex, (2) automatic simplex, and (3) duplex. A standard duplex power line carrier assembly is shown above. All three types of assemblies are identical except for the control unit—which, of course, determines the type of operation.

TRANSMITTER

The transmitter has two separate audio input circuits; one for voice and the other for tones (voice frequency carrier and supervisory control). Each input circuit has an adjustable modulation level control. The tone input is connected directly to the modulator. The voice input passes through a fast-acting 4-tube volume limiting amplifier which limits the instantaneous peak deviation of all voice input signals to 100% modulation. The tone modulation level is unaffected by simultaneous voice modulation on the same RF carrier.

Ringing or dialing signals are transmitted by shifting the carrier frequency approximately 2 kc. below the center frequency. The carrier is shifted for the duration of a ringing signal or in synchronism with dial pulses. At the remote terminal, this shifted carrier actuates a relay in the receiver chassis which (1) applies ringing voltage to the line or (2) duplicates the dial pulses to an automatic exchange. Carrier shift signaling eliminates interaction with or false action from transmitted intelligence.

RECEIVER

Excellent selectivity is provided by a 15-section filter which precedes all amplification stages. The filter is packaged separately as a plug-in unit and requires no adjustment in the field. Balanced squelch-switch tubes provide "clickless" operation of the audio squelch circuit (simplex operation only). Only 4 db. change in the RF input signal is required for full closed to open squelch action. This narrow RF input differential results in fast, positive squelch action, eliminating "feathering" (intermittent operation).

Two sockets on the receiver chassis provide optional insertion of a "carrier presence" and/or a "carrier-shift" relay. The carrier presence relay (optional accessory) can be used to turn "on" an associated VHF or microwave subcarrier transmitter in an integrated communications network. The carrier-shift relay can be used for signaling, ringing, or dialing.

CONTROL UNITS

The control unit connects the power line carrier equipment to the local telephone line and provides the necessary signaling and control circuits for the specific type of telephone operation desired. There are three types of control units, one for each type

of power line carrier assembly (manual simplex, automatic simplex, and duplex). The manual simplex control unit uses the flow of DC talking battery current to control the transmitter and receiver. The automatic simplex control unit uses the voice signals on the telephone line to control the transmitter and receiver. The switching between transmitter and receiver is accomplished entirely with vacuum tubes and occurs so quickly and quietly that it is practically indistinguishable from two-frequency duplex operation. The duplex control unit contains a hybrid circuit and circuits for transmission of ringing, dialing, and hookswitch supervision signals over the power line carrier.

LINE MATCHING CHASSIS

The line matching chassis (1) provides termination facilities for the transmitter and receiver, (2) matches the output impedance of the transmitter to the input impedance presented by the coaxial cable connected to the associated coupling unit and (3) provides additional attenuation of harmonics and spurious signals in the transmitter output.

TEST METER PANEL

The test meter panel contains an AC voltmeter, DC microammeter, db. meter and RF milliammeter, each with appropriate test leads to meter all important equipment circuits.

TEST TELEPHONE

The test telephone consists of a handset with a push-to-talk button, a hangup box, and a bell box with a push-to-ring button. The telephone will accommodate any type of operation except dial and is terminated with a phone plug for insertion in any of the appropriate chassis test jacks.

TELEPHONE TERMINATION FACILITIES

All three types of Motorola power line carrier terminals provide termination facilities for a local two-wire telephone line. All terminals also contain a talking battery supply (24 or 40 VDC up to 200 ma.) and ringing voltage supply (85 volts, 60 cycles up to 150 ma.). However, connections are provided for an external source of talking battery and/or ringing voltage if desired.

The following definitions are helpful in describing the types of telephone termination services provided by Motorola power line carrier equipment (refer to table at bottom of page):

local line: telephone line between the telephone instrument and the switchboard or exchange

common battery telephone: receives talking battery from switchboard or exchange. Requires push-to-talk button for manual simplex operation. Types of common battery telephones include:

(a) **magneto**—signals by AC ringing (either hand generator or push button)

(b) **manual**—signals switchboard or exchange by lifting handset; line selected by voice request to operator

(c) **dial**—signals an exchange by lifting handset; line selected automatically by dial pulses

local battery telephone: talking battery provided locally at telephone. Type of local battery telephone:

magneto—signals switchboard or exchange by AC ringing (either hand generator or push-button)

magneto switchboard: local lines connected to local battery magneto telephones; operated manually

PBX (private branch exchange): local lines connected to manual (common battery) telephones; operated manually

PAX (private automatic exchange): local lines connected to dial (common battery) telephones; operated automatically

TELEPHONE TERMINATION SERVICES PROVIDED BY MOTOROLA POWER LINE CARRIER EQUIPMENT

POWER TRANSMISSION LINE

POWER LINE CARRIER TERMINAL — TELEPHONE TERMINATION EQUIPMENT A

TERMINATION (A)	TYPE OF POWER LINE CARRIER EQUIPMENT	TERMINATION (B)
LOCAL BATTERY MAGNETO PHONE	AUTOMATIC SIMPLEX OR DUPLEX	MAGNETO SWITCHBOARD
MANUAL PHONE	DUPLEX	PBX
DIAL PHONE	DUPLEX (AUTO SIMPLEX WITH TONE DIAL)	PAX
COMMON BATTERY MAGNETO PHONE	MANUAL SIMPLEX (PUSH-TO-TALK)	COMMON BATTERY MAGNETO PHONE
LOCAL BATTERY MAGNETO PHONE	AUTOMATIC SIMPLEX OR DUPLEX	LOCAL BATTERY MAGNETO PHONE
MANUAL PHONE	*DUPLEX	MANUAL PHONE
PARTY LINE DIAL PHONE	*MANUAL SIMPLEX OR *AUTO SIMPLEX	PARTY LINE DIAL PHONE
MAGNETO SWITCHBOARD	AUTOMATIC SIMPLEX OR DUPLEX	MAGNETO SWITCHBOARD
PBX	*DUPLEX	PBX
PAX	*DUPLEX (E & M TRUNK)	PAX

POWER LINE CARRIER TERMINAL — TELEPHONE TERMINATION EQUIPMENT B

* SLIGHT MODIFICATION OF STANDARD ASSEM.

SIX-VOLT RADIOS AND TWELVE-VOLT CARS

As expected, the advent of 1955 automobiles found additional makes and models switching from 6-volt electrical systems to 12-volt systems. This has posed some problems for operators of radio equipped fleets.

For years, the majority of automobiles manufactured have included 6 volt electrical systems. Of those that included 12 volt systems, only a very small percentage had two-way radio equipment installed. Hence, virtually all radio equipment operated from 6 volts and 12 volt equipment was provided primarily as a customer service. Now, however, the situation is changing.

The large number of automobiles now being produced with 12 volt electrical systems brings the 12 volt radio unit into prominence. Recognizing the trend several years ago, Motorola engineers designed and began producing 6/12 volt radio equipment which operates interchangeably from both 6 and 12 volt power cables. This solves today's problems but since radio service life is greater than vehicle service life, it does not provide the answer to the problem of older radio equipment which must be reinstalled in new vehicles.

SOLUTION

As part of the Motorola philosophy of providing customer service throughout the life of the Motorola radio equipment, this entire problem of 6 volt radios and 12 volt cars has received careful evaluation. Three alternatives are recommended, the applicable alternative being determined by the operational, maintenance and cost considerations involved for the particular radio system.

A natural choice is replacement of older 6 volt equipment with new 6/12 volt, or at least 12 volt equipment. A second alternative is modification of existing radio sets through rewiring to convert the 6 volt radio for 12 volt operation. A third recommendation is use of a converter which provides 6 volts for radio operation from a 12 volt battery.

CONVERSION

Conversion instructions and parts are available from the Motorola Parts and Service Dept. for virtually all 6 volt Motorola mobile radio equipment. Parts kit costs range from approximately $12.00 to about $92.00 maximum depending upon exact model and type of conversion.

Conversion time ranges from approximately 4 hours to 15 hours. Conversion can be accomplished by any competent radio technician, by Motorola Service Stations and by the Motorola Parts and Service Dept. When conversion is not accomplished under Motorola supervision or control, Motorola's liability extends only to the warranty on the Motorola parts used in the conversion.

Conversion is required (if replacement is impractical) in smaller fleets being converted to all 12 volt vehicles and in larger fleets where the number of 12 volt vehicles is relatively large. Conversion is, of course, possible on any radio set in any size fleet but other methods of adaptation may be more advantageous.

Conversion of early models from 6 volt operation to 6/12 volt operation is not recommended nor are conversion details available.

REPLACEMENT

When the radio equipment has been in service for a number of years and is nearly or wholly amortized, replacement usually offers the best solution. When the advantages of 6/12 volt interchangeability and the superior performance of new equipment are balanced against the costs of conversion or adaptation, it may be found that the price of new equipment on a trade-in basis is the most attractive approach. Replacement, of course, can be a gradual change, the radio equipment being replaced as the vehicles are replaced.

CONVERTERS

In smaller fleets where both 6 and 12 volt vehicles will be intermixed for some time where the number of 12 volt vehicles is relatively small, and where replacement is impractical, use of a Motorola TA142 Converter has

its advantages. The converter is wired in series with the mobile power cable and produces 6 volts for radio operation from the 12 volt battery. Since all radio sets operate from 6 volts regardless of which vehicle they are in, all radio sets are interchangeable in any vehicle, provided they were interchangeable prior to introduction of the converter.

The Motorola TA142 Vibrator Converter may be used with Motorola models in the FMTR-80 and FMTRU-80 (30 watt) series, the FMTR-41 and FMTRU-41 (10 watt) series, the T44A-1 through T44A-5 (18-20 watt) series, and, with the TK225 Adapter Kit, with the FMTR-30 and FMTRU-30 series. Conversion or replacement is recommended for other models.

6/12 VOLT MODELS

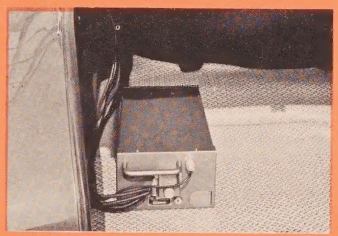
The Motorola 6/12 volt mobile models employ radio sets which operate interchangeably from either 6 volt power cables or 12 volt power cables. A 6 volt cable is installed in a 6 volt vehicle and a 12 volt cable is installed in a 12 volt vehicle. With the cable installed in the vehicle, no modifications of any kind are required to plug in a 6/12 volt unit, regardless of which voltage exists in the vehicle. And, if it is ever necessary to transfer a 6 volt cable to a 12 volt vehicle or vice versa, modification of the cable is relatively simple. Thus, for the life of the vehicle, it is never necessary to do any switching, modification or changing of plugs. The SK-9420 and SK-9421 Cable Conversion Kits for 6-to-12 volt and 12-to-6 volt conversion respectively, are designed for the cable kits used with Motorola mobile models in 10 inch wide housings (T21G, T41G, T23G, T33G and T43G series (vibrator powered) models). The SK-9415 and SK-9416 are the counterparts of these kits for use with 15 inch wide mobile housings (T51G and 6/12 volt versions of the T44A series models).

INFORMATION

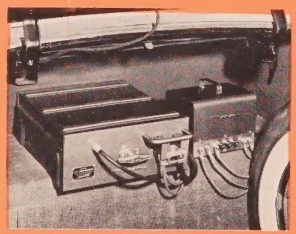
All requests for conversion information, conversion instructions and conversion kits should be made to the Motorola Parts and Service Dept. at 1414 N. Cicero Ave., Chicago 51, Illinois; 171 Parkhouse St., Dallas 7, Texas; or 811 S. "B" St., San Mateo, California. Vibrator converters may be purchased through your local Motorola Radio Communications Engineer, your local Motorola Service Station or the Parts and Service Dept. New radio equipment to replace older equipment or to add to expanding fleets is available through your local Motorola Radio Communications Engineer. For your convenience, a regional directory is given on the following page.

REMEMBER, in all requests for information, include **full** model number. Each letter and numeral is significant. In addition, on Motorola "Deluxe" Line equipment, also include transmitter and receiver model numbers.

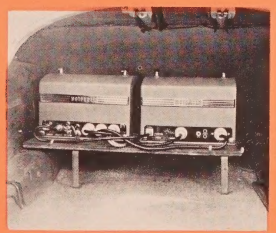
The Motorola "Dispatcher" two-way radio unit and . . . . .



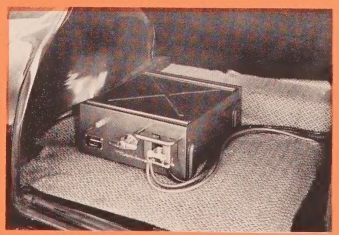
. . . . . its successor, the "Research" Line "Uni-Channel" unit (trunk mount version).



The TA142 12-to-6 volt vibrator converter.



The Motorola "Deluxe" Line two-way radio unit and . . . . .



. . . . . its successor, the "Research" Line mobile unit.

TRANSMISSIONS . . . On Communications Topics

All Cats Keep Out

Robert J. Stipp, owner of a Motorola Authorized Service Station at Hobbs, New Mexico, told us about a call one of his men had made recently to service a base station transmitter. After arriving at the cab stand which had reported the trouble, the technician was surprised to find several tubes out of their sockets and a badly bent control relay.

The cause of his trouble was a cat which, upon spying a wandering dog near the cab stand, had made a quick dash into the stand. With the dog in hot pursuit, the cat then sprang through the partially opened doorway of the transmitter cabinet to be met by hot tubes, sparking relays and shocking voltages.

After the loose tubes were replaced and the relay contacts were bent back into shape, the transmitter was as good as new, but the condition of the cat was unreported.

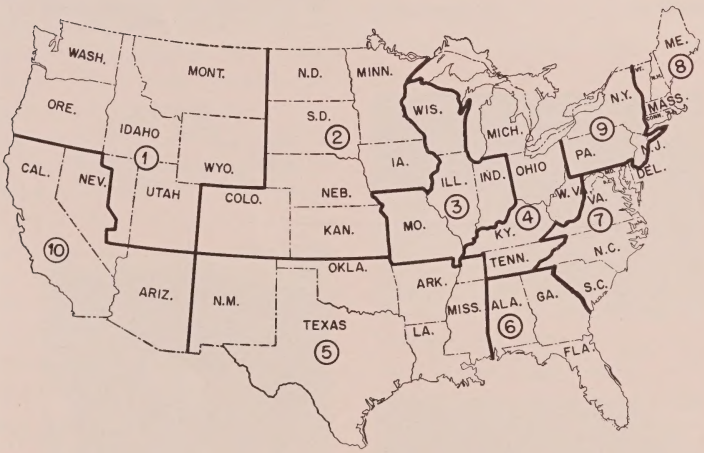
A Secondary Use

The passenger that cab driver **Robert Fordon** took on at Huron and Clark Streets in Chicago pressed a hard object to the back of Fordon's head before they had traveled very far. Fordon then reached for his money to hand it to the passenger and in doing so managed to turn on the radio transmitter of his cab. However, when he saw that his passenger was not armed, he tackled the bandit, blacked both of his eyes and then held him for the police who soon arrived as a result of the cab dispatcher's call to other cabs and police. Amazing thing about the story is that Fordon is 5′7″, weighs 140; the bandit was 6′, weighed 200 pounds.

Woodland Radio

In a recent report, the **National Forest Industries Communications** pointed out that the success of radio in the woods by early users has convinced many logging operators that two-way radio is economical, even for smaller outfits. In fact, the NFIC stated, "Some logging operations could not continue without radio," since the difference between operations with or without radio "may be the difference between profit and loss." Citing roadbuilding expenses as a major item in forest operations because each logger has to build his own roads, the NFIC said that with radio dispatching the logger can safely operate over one-lane roads with a resultant saving in costs.

REGIONAL DIRECTORY . . .



REGION 1
DONALD F. BRICKLEY, Mgr.
3833 N.E. Union Ave., Portland, Ore.
Phone: TUXEDO 5428

REGION 2
EUGENE F. BROWN, Mgr.
817 Kilpatrick Bldg., Omaha, Nebr.
Phone: WEBSTER 0017

REGION 3
HOMER L. MARRS, Mgr.
1400 N. Cicero Ave., Chicago 51, Ill.
Phone: ESTEBROOK 9-0122

REGION 4
GLENN MUNRO, Mgr.
19142 James Couzens Hwy.,
Detroit 35, Mich.
Phone: UNIVERSITY 3-6464

REGION 5
EDWARD L. FALLS, JR., Mgr.
171 Parkhouse Street, Dallas 7, Texas
Phone: STERLING 4951

REGION 6
HORACE E. BOYLAN, Mgr.
Stallings Bldg., Rm. 601, 1829 First Ave., North, Birmingham, Ala.
Phone: 4-4582

REGION 7
JOHN F. FUSSELL, Mgr.
2309 Calvert St., N. W.,
Washington 8, D. C.
Phone: ADAMS 4-5620

REGION 8
P. R. KENDALL, Mgr.
540 Main Street, Winchester, Mass.
Phone: 6-2482

REGION 9
LOWELL E. WHITE, Mgr.
102 Linwood Plaza, Fort Lee, N. J.
Phone: 8-9100

REGION 10
FRANK W. WALKER, Mgr.
6555 Sunset Blvd., Hollywood 28, Calif.
Phone: HOLLYWOOD 2-1378

WASHINGTON, D. C. OFFICE
L. HARRISS ROBINSON
Federal Agencies

NAT'L. RAILROAD SALES
R. FLOYD McCALL
4501 Augusta Blvd., Chicago 51, Ill.
Phone: SPAULDING 2-6500

Service Clinics To Be Expanded To 38 Cities

Technicians servicing Motorola communications equipment will be going back to school in increasing numbers during 1955 under an extensive field training program announced by John Tansey, national service manager of Motorola's Communications & Electronics Division.

One-day clinics are scheduled in 38 cities to bring the latest factory and field knowledge to 1,500 service men in meetings held near their homes.

The meetings will be open to Motorola Service Station personnel and to user-employed technicians. Information of particular interest to the MSS will be conveyed during brief business sessions which open the meetings. The remainder of the day will be taken up with lectures and demonstrations of receiver theory and alignment, transmitter adjustment, and servicing of portable radiophones.

Technical discussions will be conducted by Joe Jatis, assistant to the national service manager, with the aid of the regional service managers.

Eight states were represented at a recent service clinic conducted in Salt Lake City, Utah. Seated (row nearest camera) were Ralph Albison and James Bassett, Idaho State Police, Boise; Duane Williams, Casper, Wyoming; and Ver Cox, Twin Falls, Idaho.

Second row: Gene Stoker, Boise, Idaho; and Lovell Killpack, Provo, Utah.

Third row: Steve Johansik, Salt Lake City; Duane Parker, Motorola radio communications engineer, Helena, Montana; Fred Kaser, Billings, Montana; Lt. Wilford Young, Salt Lake City Police Department.

Fourth row: Jack Aramaki, Utah Highway Patrol; Al Phillips, Ogden, Utah; Francis Woods, Billings; LaMonte Boothe, Ogden Police and Fire Departments.

Standing, left to right, Don Brickley, Motorola Region 1 manager, Portland, Oregon; Ted G. Wege, RCE, Salt Lake City; Harold Van Childs, Portland; Gene Carroll, supervisor of Service Department, San Mateo Parts & Service Depot; Joe Jatis, Chicago, technical assistant to the National Service Manager; Dean Wilson, RCE, Boise; Henry Lipke, Salt Lake City; Tom Wilson, Pocatello, Idaho; Paul Crowder, Idaho Falls Police Department; and Elmo Burton, East Ely, Nevada.

★ ★

Schedule of service clinics for 1955

FEBRUARY
14, San Francisco; 17, Los Angeles; 21, Phoenix; 24, Albuquerque.

MARCH
14, Tampa; 16, Birmingham; 18, Atlanta; 21, Columbia, S. C.

APRIL
18, Raleigh, N. C.; 20, Richmond; 22, Baltimore.

MAY
9, Philadelphia; 11, Pittsburgh; 13, Elmira; 16, New York City.

JUNE
20, Hartford; 22, Boston; 24, Augusta, Maine.

AUGUST
22, Billings, Mont.; 24, Salt Lake City; 26, Boise; 29, Portland, Ore.

SEPTEMBER
12, Denver; 14, Wichita; 16, Omaha; 19, Minneapolis.

OCTOBER
17, Tulsa; 19, Dallas; 21, San Antonio; 24, New Orleans.

NOVEMBER
7, Memphis; 9, Lexington; 11, Columbus; 14, Detroit; 21, St. Louis; 23, Indianapolis; 25, Chicago; 28, Madison, Wis.

Communications from three viewpoints was the luncheon fare served at the recent International Municipal Signal Association convention for these five visitors. Dining together in Atlantic City, N. J., left to right, were Mrs. George Blount and Mr. Blount, superintendent of communications at Royal Oak, Michigan; Dan Arnold, chief of the Public Safety Services Section, Safety and Special Services Bureau of the Federal Communications Commission; Gene Goebel, national sales manager, and Lowell White, Region 9 manager, Motorola Communications & Electronics, Inc.

Cut Operating Costs 10% with 2-way Radio

2-Way Radio Gives You Complete Hourly Control of Your Trucks

With Motorola 2-way radio you can cut your operating costs 10%. Owners are reporting extra dividends of 3 cents per 100 lbs. of freight handled. Profits like this add up fast . . . 2-way Radio pays for itself in the first few months of operation.

Motorola systems permit practical, economical applications and can be readily expanded as required. Financing can be tailored to your particular requirements . . . including purchase, conditional sale, or lease.

Get the complete Motorola story yourself, soon. Write, phone, or wire the experienced Motorola Fleet Specialist in your vicinity for full details.

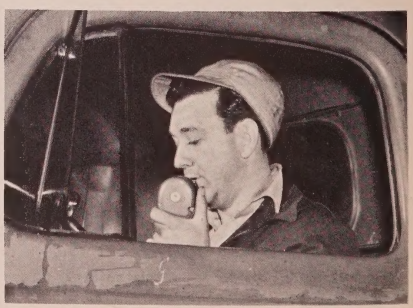
national **Motorola 2-way Radio** service

Motorola Communications & Electronics, Inc.

A SUBSIDIARY OF MOTOROLA, INC.

4501 W. Augusta, Chicago 51, Ill. • Rogers Majestic Electronics, Ltd., Toronto, Canada

Driver in a traffic snarl radios his location to headquarters. Dispatcher routes other units around tie-up, speeding deliveries and pickups — an example of the teamwork made possible with Motorola 2-way Radio.



Rush hour radio pickup call is received by incoming driver. He makes the pickup right on his way in, rather than first going home and then returning for the stop. Radio saves time, work . . . and makes many happy traffic managers.